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THE PRE-COLUMBIAN CULTIVATED PLANTS OF MEXICO

BY

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INTRODUCTION

IN recent years many important papers have been published dealing with cultivated plants, their origins and their relationships to human cultures. These studies have served to increase greatly our knowledge and understanding both of the plants and of the people by whom they were used, as well as to point out some of the areas where further research is most urgently needed. Middle America, especially from central Mexico to Guatemala, was one of the two great centers of agriculture in the New World, the other being the Andean area, and a very considerable variety of cultivated plants were known to the peoples of this region. It seems, therefore, worthwhile to attempt an enumeration of the plants which were cultivated in this area, with a discussion of the pertinent botanical literature as to their origins, distributions and importance.

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In the understanding of any biological entity, it is first necessary to recognize and to characterize the elements of the group in question. When this is accomplished, one is able to investigate profitably the distribution, history and relationships of the form or group of forms. Unfortunately, the cultivated plants present the botanist with problems the complexity of which is rarely equaled among other organisms. By becoming associated with man the plants are partially freed from the restrictions of natural selection and carried to new areas where they may hybridize with related types from which they would otherwise be isolated. Man, in addition, aids in the development of new types by conscious and unconscious selection. All this leads to an inordinate degree of variability in such populations, an understanding of which can rarely be achieved by any one limited field of approach. However, with careful and discerning morphological study and the application of cytology and genetics, the newer tools of taxonomy, and with the cooperation of the ethnologist and the archaeologist it is possible to obtain results of very great value to all concerned.

The plants and animals domesticated by man have certain unique qualities which cause them to be of interest to the anthropologist. These center about the fact that they, themselves, are organisms, biological entities which may be studied as such, as well as in their relationships to man. In other words, though shaped by their association with man, they do not so nearly represent mere products of the human mind as do many other phases of human culture which we study.

Aside from the very basic importance of cultivated plants to all advanced cultures, there are more practical

reasons for studying them. Since these plants are basic to our present cultures as well, a more complete understanding of them allows us knowingly to reshape and improve our sources of food and raw materials in a way which was not possible for our ancestors.

In the present paper particular attention will be given to the geographic origins of the plants of this area. A number of different criteria have been used in attempts to determine the centers of origin of the plants which are more widely distributed in cultivation. These criteria have largely been developed and elaborated by de Candolle (35) and Vavilov (205, 206, 207); among the more important ones may be listed the following:

1. Distribution of the same species or its apparent ancestor in a wild state. This is a point of great importance, if one can be certain that the "wild" plants are not naturalized from cultivation. This, however, is not easy, particularly considering the grave doubts which exist as to the occurrence of "primeval forest" in much of tropical America. If, of course, a useful wild plant occurs over a wide area, then it is not only possible but quite probable that it will have been cultivated independently or simultaneously in two or more areas. The avocado (*Persea americana*) may be an example of this.

2. Distribution of primitive forms within the cultivated species. This, too, is of great value, if properly interpreted. The primitive forms of a group may, however, occur either in the center of origin or on the periphery of the plant's range. Each case must be decided on its own merits.

3. Center of diversity. This valuable concept, developed principally by Vavilov (205, 206, 207), is based on the idea that the greatest diversity within a species will occur in the area where it has been in cultivation for the longest time. Also, the area where varieties of the wild

parent species occur will be the area in which the greatest hybridization might be expected. While this concept is of great interest, both to the botanist and to the plant breeder, it must be realized that secondary centers of diversity may occur, through other factors such as hybridization or topography.

4. Distribution of closely related species. Within broad limits, this criterion is quite useful. Some of the squashes (*Cucurbita*), for example, have been thought to be natives of Asia, but there are no wild species of the genus in Asia, whereas there are many in America. In studying the relationships of species, cytogenetics may at times give evidence which is of great value, as will be shown to be the case with tobacco (*Nicotiana*).

5. Archaeological evidence. If sufficiently extensive, the record of archaeology may be of very great value. With the interest in carbon 14 dating, which is possible wherever there remains much organic matter, and increased attention to plant materials, this approach will become of increasing importance. Paleobotanical evidence, which is scanty for the cultivated plants, may conveniently be included in this category.

6. Historical data. Written accounts may often be of value in interpreting recent dispersals of cultivated plants, and there remains to be done a good deal of careful work along these lines.

7. Linguistic. The interpretation of routes of dispersal through the study of plant names is of interest and of some value, but this is probably the least reliable type of evidence and must be used with great caution.

As in other such cases, the most dependable studies are those that use all available data, from every source or aspect of the problem.

One of the untouched fields in ethnobotany is the study of the development and diffusion of geographical races

within a crop plant and of their relations with culture complexes. Such races have been studied in some degree for two Middle American crop plants, maize and cotton (104, 213). In each case it has been pointed out that the development of these races must have occurred in partial isolation and must have been related to cultural centers. It is for this reason especially desirable that extensive collections, if not studies, of truly native crop plants should be made before they are further decimated by the impact of modern cultural changes.

For the present paper, material has been drawn from the literatures of botany, ethnology and archaeology, but no pretense is made of a complete coverage of any one. A better representation of the historical writings of the earlier Spanish explorers would be especially desirable, but it is a subject worthy of study in itself. Several of the important references in this field are cited, but none has received the time and attention which it deserves. Some cultivated species may have been overlooked. It is hoped, however, that most of the important cultivated plants have been included, particularly those which have changed in their biological nature and their distribution through their association with man. One cannot, in a paper of this scope, list all the useful wild plants of Mexico, though the more important of these were doubtless planted at times by the early Mexicans; information is meager or lacking for those which have been intentionally omitted. The evaluation of the published information has in some cases been aided by frequent reference to herbarium material and by some field experience. It should be borne in mind that the peoples of this region had developed both agriculture and horticulture to a rather high degree and actually possessed botanical gardens which were, at the time, unrivaled among the European peoples.

List of Species

The species are listed alphabetically, using the correct scientific names. Other names which have achieved a wide usage in the literature are in some cases cited in parentheses; these may be synonyms or names properly belonging to other species. No attempt has been made to list all of the common names; these may be sought in various works listed in the bibliography, particularly those by Standley and by some of the Mexican authors. For the sake of brevity, the number system of citation is used; and, for the convenience of the reader, the more recent or more comprehensive studies are indicated by an asterisk in the citations which follow the discussion of each species or group.

Achras: see ***Manilkara.***

Agave: ***Metl,*** *maguey, henequén.*

The species of *Agave* are, to the present day, of great importance in Mexico as sources of food, drink and fiber. Among the Aztecs they entered directly and indirectly into religion, and it has been suggested (132) that the name, Mexico, may be derived from the Náhuatl word *metl,* which is a generic term for agaves and other plants of similar appearance. Among the species anciently grown in central Mexico for aguamiel and pulque are *A. atrovirens* Karw., which is the most important species, with many variations recognized by the growers, *A. latissima* Jacobi and *A. mapisaga* Trel. The types now used as a source of distilled beverages, such as *A. tequilana* Weber, were no doubt used in pre-Columbian times at least for food, but may not have been cultivated. Since both the cultivation and the uses of the pulque agaves center in central Mexico, where the species used seem to be native, these cultivated plants may be considered as having originated in that region.

A. sisalana Perrine and *A. fourcroydes* Lem. are both extensively cultivated as fiber plants and are apparently natives of the Yucatan Peninsula, where they were probably cultivated on a smaller scale in ancient times. Many wild species of *Agave*, and of *Fourcroya*, *Yucca* and *Bromelia* as well, may be utilized as fiber sources. Even in the wild state the agaves are not too well understood, because, like the cacti, their habit is so poorly suited to the preparation of specimens. Extensive field work is necessary to study such a group properly. (43, 132*, 156, 164*, 191*, 192)

Amaranthus leucocarpus *S. Wats.*, **A. cruentus** *L.*: *Huauhtli*, *bledos*, *alegría*, amaranth.

The great importance of these plants as "cereals" in ancient Mexico is clearly indicated by the tribute lists for the empire of Moctezuma (178), which indicate an annual levy of about 200,000 bushels of "huauhtli" or amaranth seed, as compared to about 280,000 bushels of maize and 230,000 bushels of beans. The grain amaranths have been poorly understood, but a recent careful ethnobotanical study by Sauer (178) has gone far to improve the situation. *A. leucocarpus* is still grown over a wide area in Mexico and Guatemala. *A. cruentus* occurs in the same area, but less extensively, and appears to be more important in Guatemala than *A. leucocarpus*. The great decline in cultivation of this useful plant in post-Columbian times is due, at least in part, to its suppression by the Spaniards because of its important role in Mexican religious ceremonies.

The grain amaranths are, by their botanical relationships, undoubtedly of American origin. Sauer suggests that *A. leucocarpus* may be most closely allied to *A. hybridus* L. and *A. Powellii* S. Wats., both of Mexico and Central America, while *A. cruentus* seems most

closely allied to the Central American *A. dubius* Mart. The exact origins are not certain, but Sauer and some other writers, have suggested that the cultivation of the grain amaranths may have preceded maize culture. There is not yet adequate archaeological evidence on this point. (5*, 17, 18, 102*, 132*, 143, 171, 178*)

Anacardium occidentale *L.: Marañón*, cashew. The cashew is thought by some (192) to occur naturally in southern Yucatan and may possibly have been cultivated there. It has the appearance of being native from Brazil to the Antilles, especially as a strand plant. (153, 191, 192)

Ananas comosus (*L.*) *Merrill: Piña*, pineapple. The pineapple is known to have been cultivated in Mexico before European contact (52). Since it is usually propagated by vegetative means, it must have been easy for the early Americans to select and grow seedless forms. The wild species of *Ananas* are all native to the Brazil-Paraguay region, though *A. comosus* sometimes occurs as an escape from cultivation in many parts of the world (15). Though the exact ancestry of the cultivated pineapple is not known, it is almost certainly a native of South America, probably of the south Brazil-Paraguay region. (15*, 52*, 53, 54*, 149, 186*, 196, 208)

Species of the related genus *Bromelia* are sometimes planted as hedges (149) and may have been so used in pre-Columbian times. These spiny plants produce an edible, acid fruit.

Annona

The species of this genus are widely cultivated, but their histories are quite imperfectly known. The first accounts (93) indicate that several kinds were known at an early date in Mexico. There is little agreement

among authors as to their origins. Among the species which have been cited as cultivated in Mexico are the following:

A. Cherimolia *Mill.: Quauhtzápotl, chirimoya*, cherimoya.

The cherimoya is probably the best known and surely one of the best liked of the annonas. The evidence as to its origin and early distribution appears to be conflicting, doubtless due, in part, to confusion between the different species of *Annona*. Popenoe describes what he believes to be groves of wild cherimoyas in the mountains of Ecuador (151). Safford (170) and Costantin and Bois (55) present archaeological evidence of its early occurrence in Peru. Cobo (50) writes of introducing the cherimoya from Guatemala into Peru about 1630 and implies that it was unknown in Peru previous to that date. The name cherimoya is said to be of Quechua origin. Fries, in his monograph of *Annona* (80), does not comment as to the origin of *A. Cherimolia*.

A. diversifolia *Safford: Ilama.*

This species, though said to be of good quality, is not well known. It ranges from Colima and Guerrero into Central America. Safford (168) thinks it to be one of the types described by Hernández.

A. glabra *L.*

Reports as to the quality and cultivation of this species do not agree. It appears to have a very wide natural distribution as a strand plant.

A. muricata *L.: Guanábana.*

The origin of this widely distributed species is quite uncertain.

A. purpurea *Moc. & Sessé*

This species now ranges from Mexico to northern South America.

A. reticulata *L.: Anona.*

While Popenoe (153) and Standley (191) think that this is probably native in parts of Mexico and Central America, Fries (80) considers it to be West Indian.

A. squamosa *L.: Ahate.*

Fries (80) considers this species to be probably West Indian, because this section of the genus (*Atta*) has the greatest number of its species there. The section is not, however, limited to that area. This appears to be the tree which Hernández describes as native to the Pánuco region (northern Veracruz) and then introduced into Cuernavaca (93, 199). (55, 78*, 80*, 93, 150, 151, 153, 191, 196, 199)

Arachis hypogaea *L.: Tlalcacáuatl, cacahuate, maní,* peanut.

The peanut was apparently not of great importance in early Mexico, and it may actually have been introduced from the West Indies by the Spaniards as implied by Hernández (93). The compound name, "*tlalcacáuatl,*" or earth cacao, has been cited as evidence of its late arrival in Mexico (23, 129). In any case, all evidences point to a South American origin for this plant. Closely related wild forms are known from the south Brazil-Paraguay region. (5, 23, 32*, 47, 103*, 209)

Bixa Orellana *L.: Achiotl, achiote.*

This variable tree is grown for the pulp surrounding the seeds, which is used as a dye, food coloring, flavoring material and cosmetic. It is now known throughout tropical America. No careful study of *Bixa* is available, but it may possibly be of Amazonian origin. Other species which may be distinct have been described from that area. (49, 71, 93*, 133, 191, 207)

Bomarea edulis (*Tuss.*) *Herb.: Coyolxóchitl.*

This is probably the species of *Bomarea* which the Mexicans cultivated for the edible, tuberous roots and as an ornamental (93, 201). *B. edulis* is apparently a variable species with a wide natural range in Mexico and Central and South America. The Mexican members of this largely South American genus are not well understood. (14, 93, 162, 201*)

Bromelia: see under *Ananas.*

Brosimum Alicastrum *Swartz: Ox, ramón.*

Lundell (113) believes this to have been an important tree cultivated by the Mayas. The pulp of the fruit is sweet and edible, and the seed is eaten boiled or roasted or may be dried and ground into a flour. It is said to be quite palatable and nutritious. The ramón, now important as a source of forage, is abundant about ruins in Yucatan, implying former cultivation. The species is widespread and probably native from northwestern Mexico into Central America. (113*, 191*, 192)

Byrsonima crassifolia (*L.*) *DC.: Nantzinxócotl, nance, nanche.*

This shrub or small tree is of great importance in some areas. It appears to be the most important fruit of southern Veracruz and the Yucatan Peninsula during the summer months. The fruit, about the size of a large cherry, has a strange and at first unpleasant flavor, but is universally popular. The species appears to be native in savanna areas in Veracruz and Campeche and probably elsewhere. When natural groves occur near homes or villages, they are preserved and the fruit gathered for market and home consumption. (17, 133, 177, 191, 194)

Calocarpum mammosum (*L.*) *Pierre* (*Pouteria mammosa* (L.) Cronquist): *Tezonzápotl, sapote, mamey sapote, mamey colorado.*

The *mamey sapote* is a widely cultivated fruit tree which occurs from Mexico to northern South America and in the West Indies. Standley (191) and Popenoe (153) consider it as probably native to southern Mexico and Central America. (64*, 133, 153, 191*, 199)

Calocarpum viride *Pitt.* (*Pouteria viridis* (Pitt.) Cronquist): *Injerto*, green sapote.

This species, variable, though generally smaller-fruited than the last, ranges from southern Mexico to Costa Rica, but is apparently most frequently cultivated in Central America. (64*, 153*)

Canavalia ensiformis (*L.*) *DC.:* Jack bean.

This bean is now of relatively little importance. It is known from ancient archaeological levels in Peru (19, 55, perhaps not this species?), and is reported from archaeological evidences in North America (116). It may be that this large-seeded species was cultivated very early, but has since declined in popularity and usage due to the development of the better types of *Phaseolus* beans (177). Piper (147) considers it "practically certain that the plant is native to America." Its nearest relatives appear to be Mexican, Central American and West Indian in distribution. Vavilov (207) assigns it to the Mexican-Central American center of origin (diversity) with a query. (55, 115, 117, 147*, 207)

Capsicum annuum *L.*, **C. frutescens** *L.:* Chile Pepper.

The importance of the chile in Mexican diet is well known and doubtless of great antiquity. The common species, *C. annuum* and *C. frutescens*, have long been confused, but Smith and Heiser (187) have recently found that they appear to be truly distinct with strong sterility barriers preventing hybridization. Both species include

perennial forms in the tropics. The slight, but fairly constant, morphological differences listed by Smith and Heiser include characters that sometimes serve to distinguish the seeds of the two species, a fact which should be of interest to archaeologists. Centers of diversity for the peppers occur both in Mexico and in Brazil (206). The small-fruited peppers are weedy and now occur spontaneously throughout the tropics. *C. frutescens* is found under seemingly natural conditions in the canyons of northwestern Mexico (81) and even as far north as the Baboquivari Mountains in Arizona (41). Too little is now known to determine with any certainty the origin of either species. They may have spread as useful weeds at a very early date and then been cultivated independently in two or more areas. (25*, 31, 41, 81, 92, 92a*, 93, 106, 187*, 196, 206)

C. pubescens R. & P., distinguished by purple flowers and purplish-black seeds, is known from both Central and South America (92).

Carica Papaya *L.:* Papaya.

The papaya, an herb of tree dimensions with melon-like fruit, is believed to have been known to the Mayan and perhaps to the Aztec cultures (113, 149). Several wild and cultivated species of this genus are found in South America, but Solms-Laubach (188) considered *C. Papaya* to be most closely allied to wild forms occurring in Mexico and the West Indies. Hybridization may have played a part in the origin of the cultivated form. Sauer (177) gives reasons for believing it to be Central American. (113, 133, 149, 177*, 188*, 191*, 192)

The smaller-fruited *C. cauliflora* Jacq., which ranges south to Colombia and Venezuela, is listed by Standley as cultivated and perhaps native in Veracruz and Chiapas (191).

Casimiroa edulis *La Llave & Lex.: Iztaczápotl, cochitzápotl, sapote blanco,* white sapote; **C. Sapota** *Oerst.: matasano.*

These trees are grown in Mexico and Central America for their sweet fruits, which apparently vary in quality. A good account is given by Martínez (136). *C. edulis*, the sapote blanco, is Mexican in its present occurrence, while *C. Sapota*, the matasano, is largely Central American. These distributions probably reflect their origins. (133, 136*, 153, 191, 199)

Chamaedorea Tepejilote *Liebm.*, **C. Wendlandiana** (*Oerst.*) *Hemsl.: Tepejilote, pacaya.*

At least one, and probably several, species of the small, attractive palm, *Chamaedorea*, are cultivated in southern Mexico and Central America for the young staminate flower clusters, which are used as a vegetable. The unopened inflorescence is said to resemble an ear of maize in appearance and, at times, in size. Standley (193) reports them to be quite palatable. *Chamaedorea*, like most palm genera, is in need of study, and the names given here are, at best, tentative. (31, 191, 192, 193*)

Chenopodium Nuttalliae *Safford* (*C. pueblense* Reed?): *Cuauhzontli, huauhtzontli, apazote.*

Though less well known than the species cultivated in South America, this Mexican *Chenopodium* was of some importance, as indicated by its present relict occurrence in cultivation in many parts of Mexico (159, 172). It now is used principally as a green vegetable (the unripe fruit clusters), though it may have been used to some extent as a cereal, as are the South American species. *C. pueblense* Reed (58) was not distinguished from *C. Nuttalliae* by its author and may be the same species. *C. Nuttalliae* is closely related to *C. Quinoa* Willd. of the

Andean area, and Aellen (3) and others have considered it to be that species. The supposed diffferences in seed color are of no value. Hunziker (102), however, points out floral differences between the two plants. While *C. Quinoa* has close allies occurring wild in the Andean region, the situation as regards the Mexican *Chenopodium* is not clear. It may have been derived from the South American species in cultivation, though Aellen (1) implies a relationship to the North American *C. Berlandieri* Moq. A careful study of these plants should be rewarding. (1, 2, 3, 101, 102*, 143, 158, 159*, 172*, 178)

C. ambrosioides L. (Apazote or wormseed) is widely distributed and has medicinal uses. It is said to be cultivated at times (17, 194).

Cnidosculus Chayamansa *McVaugh* (*Jatropha aconitifolia* Mill.): *Chaya, chay.*

The chaya is a shrub cultivated in the Yucatan area for its young shoots and leaves, which are eaten as a pot herb. It is related to *C. aconitifolia* (Mill.) I. M. Johnst. and *C. Chaya* Lundell, both of which are more abundantly supplied with the stinging hairs which have earned *Cnidosculus* the generic name of "Mala mujer" in Mexico. The less objectionable forms of *C. Chayamansa* have doubtless been selected under cultivation. (113, 114*, 118*, 166, 192, 193, 196)

Cocos nucifera *L.; Coco*, coconut.

There has been a good deal of controversy concerning the pre-Columbian distribution of the coconut. There is now little doubt of its Old World origin. Bruman (29), after a review of the historical data, has concluded that the coconut did occur in Colima and probably elsewhere on the west coast when the first Europeans arrived. It was no doubt used by the natives, but may or may not have been cultivated. (29*, 177a, 191)

Crataegus pubescens (*HBK.*) *Steud.* (*C. mexicana* Moc. & Sessé?, *C. stipulosa* (HBK.) Steud.): *Texócotl, tejocote, manzanilla.*

The tejocote is still widely cultivated in Mexico and Guatemala for the apple-like fruit which is eaten raw or variously cooked. These are probably the apples referred to by Pomar (158) as being equal in size and flavor to the Spanish "San Juan" apples. Standley and Steyermark (194) consider it to be a native of Mexico introduced into Guatemala. (9, 18, 133, 143, 153, 158, 191, 194*, 206, 207)

Crescentia Cujete *L.: Jícara, tecomate*, calabash.

The calabash, a tree quite unrelated to the bottle gourd *Lagenaria*, produces a large fruit, the shell of which is used for utensils, as is that of the gourd. It ranges from Mexico to northern South America and occurs also in the West Indies. It is probably native in southern Mexico.

C. alata HBK. is a smaller-fruited species of western Mexico and Central America. (191*, 192, 196, 200)

Crotalaria longirostrata *Hook. and Arn.: Chipilín.*

This large herb of the legume family is grown in Guatemala and probably southern Mexico as a pot herb. It is apparently native to much of Mexico and Central America. (115, 191, 194*)

Cucurbita: *Ayotli, calabaza*, squash, pumpkin.

The pumpkins and squashes occupied a place of importance in the agriculture of both North and South America. In Mexico, they are a valuable source of edible oil seeds and the flowers and young foliage are used as vegetables. It has been suggested that the squashes were

utilized for their edible seeds long before the flesh was eaten (7, 36), because the flesh of all the known wild species is scant, bitter and unpalatable. Whitaker and Bohn (216) have summarized the available information on all the cultivated species.

C. ficifolia *Bouché* is a perennial species known from Mexico to Chile at higher altitudes. It is believed to have occurred in Peru at a very early time, but its origin is not known. Like *Canavalia*, this may be a very ancient cultigen which has since been largely replaced by the other and superior species.

C. maxima is a South American species which did not reach Mexico in pre-Columbian times.

C. mixta *Pang.* is believed by Whitaker and Bohn to be the same as the Mexican form of *C. moschata*, though the Russian workers (31, 146) believed them to be distinct and list two varieties of *C. mixta*, one from Mexico and the other from Guatemala.

C. moschata *Duch.* occurs from the southwestern United States to Colombia, though the South American forms seem to constitute a group distinct from those of Mexico and Central America. The origin of this species has not yet been determined, but it may be Central American.

C. Pepo *L.* is believed to have arisen from *C. texana* Gray of the southern United States, or a similar wild plant. It has been suggested (36) that this species was independently domesticated in the southwestern and in the southeastern United States; while this may be so, the endemic forms known to occur in Mexico and Central America (31, 36) should be considered in any study

of the species. (9, 12, 13, 31, 36, 113, 115, 146, 177a, 200, 206, 207, 214, 216*, 217*, 220)

Dahlia coccinea *Cav.* (*D. rosea* Cav.); **D. pinnata** *Cav.* (*D. variabilis* Desf.); **D. Lehmannii** *Hieron.* (*D. Maxonii* Saff.): *Acocoxóchitl, acocotli,* dahlia.

That dahlias had long been cultivated before their discovery by Europeans is indicated by the great degree of variability which these plants showed when first introduced into Europe, and by the great variety observed by Hernández (93, 173, 183). The tuberous roots of the dahlias are edible, and Camp (34) believes that they were first cultivated as food plants. The huge "tree" dahlias, *D. Lehmannii* (*D. Maxonii*) and perhaps *D. excelsa* Benth., are much cultivated in southern Mexico and Guatemala, where they serve as living fences. There is no comprehensive study of these plants available, and their relationships are but poorly understood. It is almost certain that hybridization has played a considerable part in the origin of the cultivated forms, some of which are polyploids. (34, 62, 173*, 183*, 184)

Diospyros Ebenaster *Retz.: Tlilzápotl, zapote prieto,* black sapote.

Though a popular fruit in parts of Mexico, the black sapote is found unattractive by some because of its dark colored pulp. It is related to the better known persimmon and produces a fruit of good size. Some have thought it a native of the East Indies, but the evidence seems to indicate a Mexican origin (138). There is no recent study of this genus. (31, 95, 133, 138, 153*, 164*, 191, 199)

Gossypium hirsutum *L.: Ízcatl, algodón,* cotton.

Cotton was an important fiber plant in much of Amer-

ica and is of special interest in that it has recently been the subject of detailed cytogenetic investigation (105). The cytological evidence shows that the New World cottons are allopolyploids (amphidiploids); that is, a type of stable hybrid which arises through the doubling of chromosomes in the progeny of an interspecific cross. One of the parents of the American allopolyploid cottons was *G. Raimondii* Ulbrich of Peru, or a similar (perhaps ancestral) type, while the other was an Old World type similar to *G. arboreum* L. While the explanation offered by Hutchinson, Silow and Stephens (105), that the Old World cotton was carried across the Pacific by man, has been the subject of some controversy, we are here primarily concerned with the evidence that the American cultivated cottons arose in the Andean region.

The Mexican cotton, *G. hirsutum*, appears to have arisen, *as a species*, in the south Mexican-Guatemalan region. Three varieties of this species were recognized at the time of the comprehensive work cited above, but Hutchinson (104) has since been able, with more adequate material, to recognize seven geographic races, five of which are cultivated in Mexico, a sixth occurring only in the naturalized state in coastal Yucatan. The seventh race, "Marie-Galante," the most primitive of the group, occurs extensively in Central America, the West Indies and northern South America.

The evidence that the distinct species, *G. barbadense* L., of South America, and *G. hirsutum*, have differentiated from a common ancestor while under cultivation is of very great interest. This implies a considerable antiquity for agriculture in both hemispheres and shows that definite conclusions concerning the relationships and origins of cultivated plants can be reached only after the most careful study. (104*, 105*, 133, 164, 191, 194, 203, 206, 207, 210)

Helianthus annuus *L.: Acahualli, chimálatl, chimalácatl, maíz de teja, girasol,* sunflower.

The sunflower is to be counted among the cultivated plants of early Mexico, as shown by the endemic varieties occurring there and by the descriptions of the early writers (90, 93). The cultivated sunflower, *H. annuus* var. *macrocarpus* (DC.) Ckll., which was also grown in the eastern, central and southwestern United States, is thought to have been derived from the wild *H. annuus* var. *lenticularis* (Dougl.) Ckll., which is widespread in the western United States and is limited in Mexico to the northern states. A form from Jalisco is found to resemble the Hopi sunflower as well as archaeological material from the eastern United States. While the history of the cultivated sunflower cannot yet be given in detail, it would appear to have arisen to the north of Mexico, where the wild form occurs and archaeological remains indicate long usage by man (185). (5, 89, 90*, 91*, 133, 185).

Hylocereus undatus (*Haw.*) *Brit. & Rose: Pitahaya.*

The cacti, which are so prominent in the landscape of the more arid regions, were of great importance to the early inhabitants, and a number were cultivated (see also *Opuntia*). The present species, a climbing vine, is widely grown on walls and fences as an ornamental and as a source of large edible fruits. (17, 24, 26*, 28, 68, 191)

Hyptis suaveolens *Poit.: Chía grande, chía de Colima, chan.*

The seeds of this labiate are used in the same manner as those of *Salvia hispanica* and it frequently goes under the same common name, *chía.* Like that species, it is a somewhat variable and weedy plant and now occurs in

many parts of the tropics. It is known in cultivation principally in western Mexico from Sonora and Chihuahua to Oaxaca, and perhaps in San Luis Potosí. (75*, 133, 145*)

Indigofera suffruticosa *Mill.* (*I. Anil* L.): *Xiuquílitl, jiquelite, añil,* indigo.

This American species of indigo was apparently cultivated in Mexico and Guatemala as a source of a blue pigment used extensively to dye clothing; it was also used by the Mexican women to tint their hair (93, 172). The cultivation of indigo for export was promoted by the Europeans, but has declined because of the development of synthetic dyes. The plant is now widespread as a weed and may have had a rather extensive natural distribution (33). Its cultivation probably originated in the Guatemala-southern Mexico area. (33*, 115, 133, 155, 162, 166, 191, 192, 194*, 201)

Ipomoea Batatas (*L.*) *Poir.: Camotli, camote, batata,* sweet potato.

The sweet potato was and is extensively grown in Mexico, the region of Querétaro being long noted for the excellence of this crop. It was not only widely grown in tropical America, but in Polynesia as well, a fact which has led to much discussion (58, 69, 99). Vavilov (207) assigns it to the south Mexican-Central American center of origin (diversity), though some other writers favor a South American origin. *I. tiliacea* (Willd.) Choisy (*I. fastigiata* (Roxb.) Sweet) is thought to be the ancestral form (58, 100), but its present distribution is too broad to pin-point the area in which it was first cultivated. It ranges from Florida and Mexico to South America. The information presently available seems inadequate to reach a conclusion as to the exact geographic origin of *I. Batatas.* (49, 58*, 69, 100*, 133, 197, 202, 207)

Jatropha Curcas *L.*: *Piñoncillo*, physic-nut. (see also *Cnidosculus.*)

McVaugh (119) says of this species: "The original range of *J. Curcas* doubtless included the *tierra caliente* of southern Mexico and Central America, but as it is widely planted and has been so since before the advent of Europeans . . . " Now of wide distribution in the tropics, this shrub or small tree is planted as a hedge and has medicinal uses. The seeds are said to be edible if thoroughly roasted, but are strongly purgative when fresh. *Jatropha* and *Spondias* were used as host plants for a coccid insect, the *axi* or *axin*, which was cultivated in Veracruz for a yellowish wax which it produced. This is a "domesticated animal" of the Mexicans which is not well known. The wax was and is used as a varnish and also had medicinal uses. (119*, 133, 191*, 194, 200)

Lagenaria siceraria (*Mol.*) *Standl.* (*L. vulgaris* Sér.): *Tecomate*, *bule*, bottle gourd.

The gourd is still of some importance in primitive cultures and must have been much more so to non-ceramic groups. It is thought to be a native of the Old World, perhaps of Africa, but is known from archaeological evidence to have had a very wide distribution in America at an early time. *L. siceraria* is the only species in the genus, but the closely related genera are Old World plants. Kobiakova (109) has attempted a preliminary study of this species and believes that the American gourds are derived from Africa. However, this study is admittedly based on insufficient material and American students (72, 141) have found it to be inadequate. The dispersal of the bottle gourd in America may parallel that of cotton. (51, 72*, 108, 109, 141, 177a, 198, 215*)

Lemaireocereus: see under *Pachycereus.*

Lucuma: see *Pouteria.*

Lycopersicon esculentum *Mill.: Xitómatl, jitomate, p'ak, tomato.*

The wild species of *Lycopersicon* are native to western South America, and it has long been thought that the cultivated tomato was brought into Europe from Peru. Jenkins (107), however, has given good reasons for believing that the tomato was introduced, with its Mexican name, from Mexico to Europe. It appears that the tomato was cultivated in southern Mexico and Veracruz, but not in the central Mexican highlands, where *Physalis* (q. v.) was, and still is, more important. The cherry tomato, *L. esculentum* var. *cerasiforme* (Dun.) A. Gray, the ancestral form, is now a pan-tropic weed. It is thought by Jenkins that it may have spread as a weed from South America to Mexico where it was brought into cultivation. It may be that the development of large-fruited forms was facilitated outside of the native home, because the absence of the normal pollinating agents forced self-pollination (161). (107*, 111, 112, 142, 161)

Manihot esculenta *Crantz* (*M. utilissima* Pohl), **M. dulcis** (*J. F. Gmel.*) *Pax* (*M. Aipi* Pohl): *Quauhcámotl, guacamote, yuca,* manioc.

Manioc, a starchy root crop, was cultivated as a vegetable in Mexico, though not of such importance there as in some other areas, where it is a staple food. The genus is deserving of careful study, and it is uncertain, from the available literature, whether *M. dulcis* is not one of the "sweet" varieties of *M. esculenta.* The plants of Mexico appear to have been largely of these "sweet" or less poisonous forms (4, 177). Manioc is generally thought to be of Brazilian origin, but, here too, a careful study is much to be desired. (4, 35, 71, 93, 113, 133, 177a, 179, 191, 194*, 196, 202)

Manilkara Zapotilla (*Jacq.*) *Gilly* (*Achras Zapota* L.): *Tzicozápotl*, *chicozapote*, sapodilla.

The sapodilla is widely cultivated in tropical America as a fruit tree, and the wild trees are of importance as the source of chicle, a substance known and used by the ancient Mexicans. Its wood is extremely durable and is said to have been used by the Mayas in temple construction. The name "*Achras Zapota*" is well established in the literature, though there may be good botanical and nomenclatural reasons for abandoning it (82). Further study or action of the International Botanical Congress may conserve the older and better known name. *Manilkara Zapotilla* is a highly variable species, thought to be native from southern Mexico to Costa Rica. (63*, 82*, 133, 153, 191)

Nicotiana Tabacum *L.*; **N. rustica** *L.*: *Yetl*, *picietl*, tobacco.

Various species of tobacco were cultivated and used almost throughout the Americas. There is no agreement as to which species was the most important in pre-Columbian Mexico. Setchell (182) considered *N. Tabacum* to be the principal tobacco of Mexico, while Spinden (190) considers *N. rustica* to have been the only species cultivated there, at least in the central highlands. It is probable that *N. Tabacum* was known and cultivated at least in southern Mexico. The plant figured by Hernández (Plate XX) is clearly *N. rustica*, but the "quauhyetl" which he mentions may be *N. Tabacum*.

Nicotiana has been the subject of intensive cytogenetic study with results of value both to botany and to anthropology. Like the New World cultivated *Gossypium*, both of these species of tobacco are allopolyploids. *N. rustica* appears to have arisen as a hybrid between the progenitors of two modern species which occur in the

Peruvian Andes (83, 84), while *N. Tabacum* probably arose in a similar manner on the eastern slopes of the Andes, perhaps in the region of Northern Argentina (84, 88). The latter, at least, is not known from the wild state (85), and it or both may have arisen in cultivation. From their distribution at the time of European discovery, it would seem that *N. rustica*, which was then the cultivated tobacco of the eastern United States, was the first to be cultivated, or at least the first to be widely dispersed. *N. Tabacum*, arising or entering cultivation at a later date, was superior to the earlier species, especially at lower altitudes, and largely replaced it in South America and parts of Middle America. The European cultures served to hasten the replacement of *N. rustica*, and it is still peripheral in its distribution, being grown principally as a garden tobacco in the Old World. It may be that indigenous species of tobacco were early cultivated in Mexico, as they were in much of the western United States (182), and later replaced by the South American species. A monograph of *Nicotiana*, by Goodspeed, is in press and should be of interest. (83, 84*, 85–88, 93, 177a, 182*, 190, 196a)

Nopalea cochenillifera (*L.*) *Salm-Dyck: Nopal nocheztli.*

A cactus similar to *Opuntia* in aspect, this species is well known as the plant on which the early Mexicans cultivated the cochineal insect, the source of a highly valued red dye (26). This cactus is spineless, apparently the result of selection under cultivation. This species of *Nopalea* is probably native to some part of southern Mexico. The present cultivation of cochineal in Oaxaca is said to utilize varieties of *Opuntia ficus-indica*. (24, 26*, 49, 68, 93, 158, 191*)

Opuntia ficus-indica (*L.*) *Miller;* **O. megacantha** *Salm-Dyck;* **O. streptacantha** *Lemaire;* **O. amyclaea** *Tenore: Nochtli, nopalli, tuna* (fruit), *nopal* (plant), prickly pear.

Opuntia, which figures in the ancient Mexican symbol of the eagle and the *nopal*, is and has long been of great economic importance in parts of Mexico. The early writers were impressed by the great variety of tunas or *nochtli* in the Mexican gardens and markets (93, 158, 174). Several species are extensively grown for their edible fruits, which are variously prepared, and the young stems, or "joints," are used as a vegetable. The plants are easily multiplied by cuttings, so that fine hybrids and varieties can be selected and propagated true to type. Most of the cultivated Opuntias are doubtless native to central Mexico. (17, 24, 26*, 28, 49, 68, 93, 158, 164, 174, 191*)

Pachycereus emarginatus (*DC.*) *Brit. & Rose: Órgano, pitayo.*

This cactus is used for picturesque living fences in many parts of Mexico. Other columnar types, such as species of *Lemaireocereus*, were probably also cultivated for fruit, protection and ornament. (24, 26*, 28, 68, 191)

Pachyrrhizus erosus (*L.*) *Urban: Xícama, jícama,* yam bean.

The yam bean is extensively cultivated in Mexico for its turnip-like roots, which are usually eaten raw and are said to be very palatable. It appears to be native to lower elevations in central and southern Mexico and northern Central America, and is now widely cultivated and naturalized in many parts of the world. Other species were cultivated in South America. (17, 48*, 113, 133, 192, 202)

Panicum sonorum *Beal: Sauwi*, panic grass.

This is a little-known grass cultivated by the Warihio of Sonora and Chihuahua as a cereal (81). It is said to have been cultivated also by the Cocopa (41, 96). It is probably an indigenous cultigen of this area, though the species also occurs in southern Mexico. It is of particular interest since very few true cereals, other than maize, were cultivated in the New World. Two South American grasses of similar status are now believed to be extinct (177). (41, 81*, 96).

Parmentiera edulis *DC.: Quauxílotl, cuajilote.*

This tree, related to the calabash, is cultivated in many parts of Mexico for its sweet fruits which are eaten either raw or variously cooked. The tree now ranges from Tamaulipas and Sinaloa to Central America and is probably native at least to southern Mexico. (17, 133, 191*, 200)

Persea americana *Mill.: Ahuácatl, pahua, aguacate*, avocado; **P. Schiedeana** *Nees: Chinini, coyó.*

The nutritious avocado, now becoming more popular in the North, has long been an important food in Middle America. There are three groups recognized within *P. americana:* the Mexican race, a thin-skinned, small-fruited type centering in the Mexican highlands and sometimes designated as *P. americana* var. *drymifolia* (Schlecht. & Cham.) Blake; the Guatemalan race, principally Central American; and the "West Indian" race which occurs in the lowlands of Central America and northern South America. Williams (219) states that the complex of wild forms, to which *P. americana* is most closely related, ranges from Mexico to Honduras and probably to Costa Rica. Popenoe (152) has found what he believes to be wild trees of the Mexican race on the slopes of Orizaba and supposed wild trees of the Guatemalan

race in central Guatemala. These probably indicate the centers of origin of these two cultivated races from varieties of the same species or from closely related species. The West Indian race, which may not have occurred in Mexico until recent times, seems to be more closely related to the Guatemalan race than to the Mexican and probably arose somewhere in lowland Central America. Hybridization may have played some part in the development of these races and certainly has been important in the formation of the modern commercial varieties (8). (8, 21, 97*, 133, 152, 191, 194*, 219)

P. Schiedeana is a distinct species ranging from southern Mexico to Panama, but it is rarely cultivated except near Orizaba, Mexico, where it is of considerable importance (153).

Phaseolus: *Ayecote*, *bul*, *frijol*, bean.

The bean is one of the ancient American trinity, maize-bean-squash, and is nowhere more important than in Mexico. The genus is not as well known as its economic value merits. A recent Russian paper, which the present author has not seen, is cited by Carter (36). Several species of beans are cultivated in Mexico:

P. acutifolius *A. Gray:* Tepary.

This species is less important in Mexico than it is in the southwestern United States, where its resistance to drought and heat give it a great advantage over *P. vulgaris* and where it has its center of diversity. The wild forms of the tepary bean occur from western Texas to Arizona and southward to Jalisco. The most probable center of origin for the cultivated plant is northwestern Mexico (36). It is now found in cultivation in Chiapas and Guatemala, but its antiquity in these regions is not known (36, 79*).

P. coccineus *L.* (*P. multiflorus* Willd.): *Ayécotl, címatl,* scarlet runner bean.

This species appears to be known in the wild state in Mexico and Guatemala (148), and is thought by the Russian workers (31) to have its center of diversity in Guatemala. It appears to be of some importance both in Mexico and in Guatemala. The fleshy root may also have been eaten (202).

P. lunatus *L.:* Lima bean.

This species, too, is known as a wild plant in Mexico and Guatemala. Mackie (117) places its center of diversity and origin in Guatemala and traces three routes of diffusion from this center, each with a different type. One group of the lima bean, the northern or "Hopi" branch, was dispersed northward through Mexico and into the United States. A second group, the "Inca" branch of the species, extends into Andean South America and includes the varieties with the largest seeds. The third group, the "Carib" branch, occurs in the West Indies and lowland South America. While the routes followed by these three groups may not be quite as traced by Mackie (36), the groups and trends seem to be valid. For a discussion of the synonymy of this species and its subdivisions see Van Eseltine (204).

P. vulgaris *L.: Bul, frijol,* common bean.

This is the most important bean of most of America. The center of diversity of this species is in Mexico and Guatemala (31), and wild plants of *P. vulgaris* have been found in this region in recent years (115, 177). The center of origin for this important species was probably somewhere in the Mexican-Guatemalan area, though Burkart (33a; pp. 429, 545) reports what he believes to be wild forms of this and of the preceeding species from Argentina. (31, 36*, 37, 79, 115, 117*, 133, 158, 194*, 204)

Physalis ixocarpa *Brot.*: *Tómatl*, *miltómatl*, *tomate*, *tomatillo*, husk tomato.

This is an important plant in the central Mexican highlands where the fruits are used in stews and sauces. The fruits are quite large and the plants highly variable. In some areas two varieties are recognized, at least in the markets; one with the husk close-fitting about the fruit and the other with a larger husk. These seem to be the two forms illustrated by Rose (164). The species is probably native to central Mexico. The cultivated *Physalis* of the Guatemalan highlands is usually referred to *P. pubescens* L., but may be *P. ixocarpa* or some other species. *P. peruviana* L., of South America, is not closely related. (115, 137*, 149, 164, 167, 193)

Polianthes tuberosa *L.*: *Nardo*, tuberose.

The tuberose, a widely cultivated ornamental, is not definitely known as a wild plant, but it is almost certainly a native of Mexico, as are the other species of the genus. Double forms are frequent, and the plant probably has a long history of cultivation. (14, 165*, 194*)

Pouteria campechiana (*HBK.*) *Baehni* (*Lucuma salicifolia* HBK.): *Costiczápotl*, yellow sapote.

This fruit tree ranges from southern Mexico to Panama, but is cultivated principally in Mexico according to Popenoe.

P. hypoglauca (Standl.) Baehni, a similar species, is cultivated and perhaps native from San Luis Potosí and Veracruz to northern Central America. (64*, 153*, 191, 199)

Protium Copal (*Schlecht. & Cham.*) *Engler*: *Copal*, *pom.*

This tree was important among the ancient Maya for

its resin, which was used principally as an incense in religious ceremonies and which is still of considerable importance in highland Guatemala (194). Although the tree is reported as having been cultivated at the time of the conquest (196), the resin is now obtained from wild sources. *P. Copal* is restricted to southern Mexico and northern Central America and is doubtless native there. (192, 194*, 196*)

Prunus serotina *Ehrh.* subsp. **Capuli** (*Cav.*) *McVaugh* (*P. Capuli* Cav., *P. salicifolia* HBK.): *Capulín, cereza*, capulin cherry.

The Mexican cherry was noted by the early European observers as equal in size and quality to the European cherries but of a different flavor (49, 93, 191). It is apparently native to the Mexican highlands, though early introduced into South America, where it is now much grown, especially in Ecuador (154, 194). Cobo (50) tells of its introduction into Peru. McVaugh (120) has reemphasized the close relationship of the capulin to *P. serotina* subsp. *serotina*, a wild cherry of the United States and Mexico. (49, 50, 120*, 133, 153, 154*, 158, 191, 194*)

Psidium Guajava *L.: Xalxócotl, jalocote, guayaba*, guava; **P. Sartorianum** (*Berg.*) *Niedenzu; Arrayan, guayabilla.*

The guava is a shrub or small tree which is widely distributed in tropical America and, though valued for its edible fruit, may occur in such abundance as to be a weed and a nuisance. *P. Guajava*, the best known species, ranges from Mexico to Peru. Whether or not man played a part in bringing about this range, it is difficult to determine. *P. Sartorianum*, of Mexico and Central America, is also cultivated to some extent.

P. Friedrichsthalianum (Berg.) Niedenzu is largely Central American and may never have been cultivated in Mexico. The wide ranging *P. guineense* Sw. (*P. molle* Bertol.) is apparently inferior and little grown. (116, 133, 149, 150, 151*, 191*)

Salvia hispanica *L.* (*S. Chian* La Llave, *S. polystachya* Ort.): *Chía, chiantzozolli* (see also *Hyptis*).

The seeds of *chía* are widely used in Mexico to prepare a nourishing and refreshing drink which is highly esteemed by many. They may be toasted and ground or merely stirred into water, and produce a copious mucilaginous jelly. This drink is frequently sweetened and variously flavored. The seed has also long been the source of an excellent drying oil used in painting. This species is evidently a native of central Mexico. Bukasov (31) states that it is also cultivated in Guatemala (as *S. Chia* Fern.). (31, 49, 74*, 110, 133, 145*, 162)

Sambucus mexicana *Presl.: Sauco*, elderberry.

This shrub or small tree is occasionally seen in gardens or hedgerows (personal observation) and is said to be cultivated for its small fruits (191). The available information concerning this plant is inconclusive. (17, 191)

Sechium edule *Sw.: Chayotli, chayote, güisquil.*

The chayote has long been an important cultivated plant in Mexico. Not only are its somewhat squash-like fruits produced in abundance, but the young leaves and shoots are useful as greens, and the large, starchy roots are also eaten, only a part of the root cluster being harvested at any one time to avoid killing the vine. The greatest diversity of this species occurs in Guatemala, where a wild form is said to occur (115, 206). (9, 56, 98*, 115, 133*, 193, 202, 206)

Solanum tuberosum *L.*: *Papa*, potato.

While the potato seems scarcely to be considered as a pre-Columbian cultivated plant of Mexico, McBryde's observation of a small, semi-cultivated form ("*S. andigenum* Juz. & Buk. forma *guatemalense* Buk.") in Guatemala, which he considers to be a pre-Columbian introduction from South America, deserves attention (115). If this potato was actually pre-Columbian, it would appear that cultivated *S. tuberosum* was present in Middle America, but that it was not sufficiently attractive to the people of this region to spread widely. Close relatives of *S. tuberosum* occur in Mexico and the tubers of wild plants were utilized to some extent. Correll (60) interprets *S. tuberosum* and *S. andigenum* as ecological forms of one species. (60, 115)

Spondias purpurea *L.*: *Xócotl, jocote, jobo, ciruela;* **S. Mombin** (*S. lutea* L.): *Jobo, cozticxócotl, ciruela amarilla.*

The jocote is a widespread and important fruit tree in Mexico and Central America. It is easily propagated by cuttings and is therefore often grown as a hedge or fence-row plant. *Spondias*, like *Jatropha* (q. v.), was used as a host for the wax-producing coccid insect, *axin*. *S. purpurea*, the better known of the two species, is widespread in tropical America and probably native in parts of Middle America, and perhaps elsewhere. *S. Mombin* is generally stated to be inferior and less cultivated; it is probably a native of Central America and perhaps also of southern Mexico. Both species are highly variable and a careful study of *Spondias* would be most welcome. (133, 153, 164*, 191, 192, 194*)

Tagetes patula *L.*; **T. erecta** *L.*: *Cempoalxóchitl, flor de los muertos*, marigold.

Species of *Tagetes* are widely used in Mexico as medicinal plants and at times seem to carry some ceremonial significance (17, 164). The showy and variable *T. erecta* and *T. patula* must, like the dahlia, have had a long history of cultivation as ornamentals in Mexico. (17, 49, 50, 93, 133*, 143, 164, 192)

Taxodium mucronatum *Ten.: Ahuéhuetl, ahuehuete,* Mexican bald cypress.

Though perhaps not properly listed as a cultivated plant, the noble *ahuehuete* surely deserves mention. It is known to have been planted by the ancient Mexican rulers in their parks and gardens, and a number of the trees thought to have been planted by Netzahualcóyotl and Moctezuma II are still living. A good account is given by Martínez. (135*, 191)

Theobroma Cacao *L.;* **T. angustifolium** *DC.: Cacao;* **T. bicolor** *Humb. & Bonpl.: Patachtli, pataxte.*

Cacao was highly valued in Mexico as the source of *xocóatl*, a drink somewhat different from the modern chocolate. The seeds were often used as a medium of exchange. *T. Cacao* is a rather variable population and some authors have recognized several species on the basis of fruit shape and other characters. Cheesman (45) recognizes two main groups. The "Criollo" varieties, with plump seeds and pale or unpigmented cotyledons, produce the highest quality of seeds, and are thought to be the original cacao varieties of Mexico and Central America. These are known to occur also in Colombia and Venezuela, but were apparently not cultivated there in pre-Columbian times. The "Trinitario" varieties (*T. leiocarpa* Bernoulli), with flattened seeds and purple cotyledons, have been brought into cultivation in relatively recent times from wild Amazonian trees. The early de-

scriptions by Sahagún and Cobo (50, 174), however, seem to refer to "Trinitario" varieties in Mexico rather than to "Criollos"; perhaps the seed of *T. angustifolium* resembles that of the "Trinitario" forms. The present commercial cacaos of America are mostly hybrids involving both groups. Cheesman places the "center of origin" of *T. Cacao* in the upper Amazon. This may have been a center of dispersal of wild *T. Cacao*, but it was clearly brought into cultivation somewhere in Central America or southern Mexico. For the purpose of the anthropologist, a distinction must be drawn between the origin as a cultivated plant and the history of the plant before cultivation or association with man. The latter subject is, however, of great interest to botanists.

T. angustifolium, of Central America and southern Mexico, is said to be cultivated to a considerable extent in Mexico, particularly about Soconusco, Chiapas, and apparently produces a good grade of cacao (191, 194). *T. bicolor* ranges from southern Mexico to northern South America and is generally considered inferior in quality to *T. Cacao*, but is cultivated and used in some areas. (44, 45*, 46, 49, 50, 70, 71, 133, 191*, 194*)

Tigridia pavonia (*L.f.*) *Kerr.: Oceloxóchitl, cacómitl, cacomite*, tiger-flower.

Now known principally for its beautiful flowers, the tiger-flower was cultivated by the Mexicans for its edible corms as well as for ornament. It is evidently a native of central Mexico. (50, 93, 133*, 143)

Vanilla planifolia *Andr.* (*V. fragrans* (Salisb.) Ames): *Tlilxóchitl, vainilla*, vanilla.

Vanilla was known to the Mexicans and used especially for flavoring chocolate. This vine occurs from tropical Mexico to northern South America, but its pre-Colum-

bian use extended only south to Costa Rica (30). In Mexico its cultivation has long centered in southern Veracruz, and it was probably little cultivated in other areas. (30*, 59*, 60a*, 133)

Yucca elephantipes *Regel: Iczotli, izote*, yucca.

This large tree is much planted for hedges, especially in Central America, where it is apparently introduced. The flowers are valued as a vegetable. Standley (192) considers it to be a native of Veracruz. *Y. aloifolia* L. is also cultivated at times. (115, 133, 191*, 192, 193, 194*)

Zea Mays *L.: Tlaolli, centli, maíz*, maize, Indian corn.

Maize has long been the most important crop plant for most of the Americas and certainly retains that title in Mexico. The interest in this plant has been such that an overwhelmingly voluminous literature has developed concerning the genetics, cytology, morphology, relationships, importance and origin of this cereal. There remain, nonetheless, many unanswered questions about maize and it will doubtless provide a fertile field for investigators for many years to come.

The nearest ally of maize is teosinte, *Euchlaena* (*Zea*) *mexicana*, which occurs apparently as a wild plant in Guatemala and Chiapas and as a weed of cultivated areas in many parts of Mexico. Teosinte has at times been thought to be the wild ancestor of maize, but this idea now has very few adherents. Mangelsdorf and Reeves (129) have suggested that teosinte is actually of hybrid origin, maize and a species of *Tripsacum*, a more distantly related grass, being the parent species. Stebbins (195, p. 277) suggests that a cross might have been more readily effected between primitive maize and some extinct species of *Tripsacum*, with a lower chromosome

number, than between the modern representatives of these genera, which cross only with difficulty. Though there is not total agreement as to the origin of teosinte, there can be little doubt that it has played a major role in the evolution of modern maize, through hybridization and introgression. Mangelsdorf and his collaborators (123–131) have supported the hypothesis that the most primitive maize is both tunicate (a pod corn) and a popcorn. This seems to have been supported by archaeological and other studies (131, 213). Mangelsdorf and Reeves further hypothesized that the ancestral region for maize should be sought in the South American lowlands, where some primitive forms are still found. More recent evidences seem to indicate a peripheral nature for these South American types. There is paleontological and archaeological evidence that maize is of greater antiquity in North America than in South America (16, 77, 131). Maize pollen was recovered at a depth of seventy meters in the Valley of Mexico; this is interpreted as representing wild maize growing in that region in the Pleistocene (16, 67, 77, 181). Archaeological material from Bat Cave, New Mexico is of particular interest (131). The maize from the lowest level of these deposits (about 2500 to 2000 B.C.) is a very small-eared form and appears to be both a pod corn and a popcorn. Cobs in later levels are larger and show evidences of introgression from teosinte.

Wellhausen et al (213) have recently published a valuable book on the races of maize in Mexico. They have recognized and characterized at least twenty-five distinct races which are grouped into four classifications: "Ancient Indigenous," primitive popcorns of relictual distribution, two of which are weakly tunicate; "Pre-Columbian Exotic," races believed to have been introduced into Mexico from the south in prehistoric times; "Prehistoric Mestizos," derived from races of the first

two categories through hybridization; and "Modern Incipient," less stable races, apparently of relatively recent origin and dispersal. With the basis given by these authors, it should eventually be possible to make an extensive study of archaeological remains of maize from Mexico and adjacent areas and to correlate in time and space these races with their phylogeny and with other culture traits. Indeed, a better framework for American prehistory could scarcely be desired.

The exact origin of maize is yet unknown and will probably continue to be a source of speculation and controversy for some time to come. At present, the evidence seems to favor the Mexican-Central American area as the home of this cereal. The Chiapas-Guatemala area may have been the center of origin for races affected by introgression from teosinte (127). The Andean area has also been a center of dispersal, especially, it would seem, for large-kerneled races, including flour and sweet forms. (6*, 11, 16, 27, 38, 65, 66, 67, 76, 93, 94, 123, 124, 125*, 127*, 128, 129*, 130, 131, 157, 160, 195, 211, 212*, 213*, 218)

The Geographic Origins of Mexican Cultivated Plants

On the basis of the data which have been discussed, it is possible to arrange the cultivated plants tentatively according to geographic origins. The divisions which are recognized within the Mexican-Central American region do not represent well defined centers or culture complexes, but rather geographic regions with some ecological character. Some plants probably overlap two of these subdivisions in their origins and a few are doubtless assigned to the wrong subdivision. The divisions and assignments are, of course, distinctly tentative and subject to revision.

1. Mexican-Central American Area . . . 71 species[1]

a. Plants whose origins within this area are as yet difficult to localize . . . . . 8 species

Cucurbita mixta
C. moschata
Hylocereus undatus
Phaseolus vulgaris
Theobroma Cacao
T. angustifolium
T. bicolor
Zea Mays

b. Northern Mexico and the adjacent United States 4 species

Cucurbita Pepo
Helianthus annuus
Panicum sonorum
Phaseolus acutifolius

c. Central Mexico (w=western Mexico) 24 species

Agave atrovirens
A. latissima
A. mapisaga
Amaranthus leucocarpus
Annona diversifolia (w?)
Casimiroa edulis
Crataegus pubescens
Dahlia coccinea
D. pinnata
Diospyros Ebenaster
Hyptis suaveolens (w)
Opuntia amyclaea
O. ficus-indica
O. megacantha
O. streptacantha
Pachycereus emarginatus
Persea americana (Mexican race)
Physalis ixocarpa
Polianthes tuberosa
Prunus serotina subsp. *Capuli*
Salvia hispanica
Tagetes erecta
T. patula
Tigridia pavonia

d. Southern Mexico and northern Central America (except for Guatemalan highlands). This is doubtless the least well defined and most inclusive of the subregions delineated here. (y=Yucatan, m=southern Mexico, ca=Central America) 27 species

Agave fourcroydes (y)
A. sisalana (y)
Annona purpurea ?
Brosimum Alicastrum
Byrsonima crassifolia
Calocarpum mammosum
C. viridis (ca)
Carica Papaya
Chamaedorea Tepejilote
C. Wendlandiana
Cnidosculus Chayamansa (y)
Crescentia Cujete
Indigofera suffruticosa
Jatropha Curcas (m)
Manilkara (*Achras*) *Zapotilla*
Nopalea cochenillifera (m)
Pachyrrhizus erosus (m)
Parmentiera edulis
Persea Schiedeana
Pouteria campechiana
P. hypoglauca
Protium Copal
Psidium Sartorianum
Spondias Mombin (ca)
S. purpurea
Vanilla planifolia (m)
Yucca elephantipes (m)

[1] Note that races of the avocado, *Persea americana*, are listed under two subregions.

e. Guatemalan Highlands . . . . . 8 species

Amaranthus cruentus
Casimiroa Sapota
Crotalaria longirostrata
Dahlia Lehmannii
Persea americana (Guatemalan race)
Phaseolus coccineus
P. lunatus
Sechium edule

2. Andean Area . . . . . 6 species

Annona Cherimolia
Chenopodium Nuttalliae
Gossypium hirsutum
Lycopersicon esculentum (or cultivated independently in Mexico)
Nicotiana rustica
N. Tabacum

3. Lowland South American (Brazil-Paraguay) Region 3 species

Ananas comosus
Arachis hypogaea (post-Columbian in Mexico?)
Manihot esculenta

4. Plants which are at present difficult to assign to any of the above areas, with the author's guesses in parentheses . . . . . 8 species

Bixa Orellana
Canavalia ensiformis (Mex.)
Capsicum annuum
C. frutescens (Mex.)
Cucurbita ficifolia
Ipomoea Batatas
Lagenaria siceraria (via Andean region?)
Psidium Guajava (Andean?)

From the above lists it will be seen that over eighty species of plants are considered as having been cultivated in Mexico before European contact. Some may think this number to be excessive; it must be recalled, however, that agriculture was developed to a high degree in parts of Middle America and that the ecology of the area is conducive to a great variety of crop plants. In almost all instances, I believe, a very good case can be made for considering these plants to have been cultivated in pre-Columbian Mexico. The greater number are indigenous either to Mexico or to adjacent areas. Some of the indigenous plants are of secondary importance, but the list also includes plants of such prominence as maize, beans, agave, avocado, and species of amaranth and squash. Six species, including cotton and tobacco, are believed to

be of Andean origin. Though the species of cotton in Mexico is not the same as that of the Andean area, it is believed that they both diverged from a common ancestor under cultivation and that cotton culture in the New World stemmed from the Andean area. Two or three plants may be considered as having diffused from lowland South America under cultivation. There remain eight species which the author hesitates to assign to any of these areas. All, of course, are now very widespread, and this portion is not completely comparable to the rest of the list, which includes many local types. It may be expected that several, if not most, will prove to be natives of the Mexican region.

Mangelsdorf and Reeves (129), after a survey of the American cultivated plants, conclude that there had been no direct interchange of crop plants between the Andean and the Middle American areas, but that both regions had received some plants from lowland South America, thus accounting for the relatively few species that occur in both areas. Hutchinson, Silow and Stephens (105), on the other hand, hypothesize an early exchange of plants between these two centers, with little or no subsequent exchange. It is doubtful that "direct" transfer of plants between Mexico and the Andes occurred at any time before European contact. Plants traveled by gradual diffusion and those which occurred in both regions were mostly the ones which could and would be grown in the intervening areas. The indigenous tuber crops of the Andes would do poorly at lower elevations, and there would seem to be little incentive for their cultivation where *Manihot* and *Ipomoea* were both available and better adapted. The different Andean plants in Mexico were probably not of contemporaneous introduction. Cotton was clearly early, as was probably *Chenopodium*, if it is Andean. *Nicotiana rustica* was much earlier than

N. Tabacum, and *Lycopersicon* may have been fairly late. If *Annona cherimolia*, *Chenopodium Nuttalliae* and *Solanum tuberosum* are all truly Andean in origin and pre-Columbian in Mexico and Guatemala, a good case might be made for direct transport over a considerable distance; all are plants that thrive only in the temperate highlands.

The plants which are definitely of lowland South American origin are few and of relatively little importance. *Ananas* is almost certainly South American and pre-Columbian in Mexico, *Manihot* is of less certain origin but also pre-Columbian in Mexico, although both may be relatively late. *Arachis* is certainly late and perhaps post-Columbian.

While some of the doubtful domesticates may ultimately prove to be exotic, the bulk of the plants cultivated in the Mexican area are indigenous, and the native agriculture has retained its character to a remarkable degree under the impact of European domination (31). It must be concluded that the complex of domesticated plants which developed in Middle America constituted a well balanced and stable system of agriculture, which is thereby resistant to extensive establishment of new cultivated plants (with domestic animals, it was quite otherwise). The inertia of cultural patterns is no doubt also involved, but many other areas have proven to possess far less stable systems.

A really comparable list of the pre-Columbian cultivated plants of the Andean region is not available, but would be of great interest. A nearly or quite equal number of cultivated species could probably be enumerated for this area which is noted for its endemic crops.

It has been argued, on competent grounds, that agriculture has had several independent centers of origin in the New World (36, 175). While the origins and present distributions of the cultivated plants cannot alone throw

much light on this, the data presented here in no way conflict with multiple and independent origins for American agriculture. Archaeological evidence seems at present to support this hypothesis and may be expected to add important information in the future (19, 20, 36, 131). Some writers (9) have upheld a very great antiquity for New World agriculture. The information on this is yet fragmentary, but here too, the joint efforts of archaeology and botany are doing much to clarify the picture and indicate a quite respectable age for agriculture in this hemisphere (19, 131).

With attention being focused on the ultimate origins of agriculture, more thought is being given to the manner in which plants first entered cultivation. However, less is being heard of the ingenious savage who decided to return seed or roots to the soil and thereby revolutionized culture overnight (I suspect that early man had an adequate understanding of the seed long before he used this knowledge in agriculture). It seems more probable that the development of agriculture, whatever its pattern, was a gradual process. Some authors (9, 10, 176, 178, 205, 206) have drawn attention to the weedy "camp-follower" element among our cultivated plants, those plants which might be expected to invade camp sites and trash heaps and to be encouraged by man. The hypothesis of a gradual development from such a nearly commensal relationship has much to recommend it. The alliance was probably never purely commensal, but to some degree mutualistic or symbiotic from the beginning, with both members profiting from the association. Instances of semi-cultivation in peripheral areas of North America are described elsewhere (42), and several are known for tropical America. A considerable number of New World cultivated plants are such "weedy" types and many are still to be found on the trash heap; such plants include:

Amaranthus, *Capsicum*, *Chenopodium*, *Cucurbita*, *Helianthus*, *Lycopersicon*, *Psidium*, *Salvia* and *Solanum*. Many other plants, such as the cacti and fruit trees, must have been selectively encouraged before agriculture began, just as they are at the present day.

Anderson, in particular, has emphasized the role played by man in the dispersal of useful plants into new areas. This allows hybridization between varieties, and hybridization and introgression between related species. Both of these processes serve at times to promote "weediness" and always to increase the variability of the populations involved, a very important factor in the origin and development of cultivated plants (7, 10, 126). This relationship between man and useful plants doubtless began before agriculture, when man first carried a fruit with him for a while before eating it, thus discarding the seed in a new area.

One cannot discuss the origins of New World agriculture without mentioning the question of trans-Pacific cultural contact. Evidence has been presented concerning several cultivated plants, notably *Gossypium*, *Amaranthus*, *Ipomoea*, *Lagenaria* and *Cocos*, which has been interpreted as indicating early cultural contact between southeast Asia and tropical America (69, 105, 178). This evidence has been discussed at length and opinion is sharply divided (39, 40, 108, 128, 138, 139). This controversy has brought forth, on one extreme, vituperative and dogmatic insistence that no such contact has or could have occurred, and, on the other hand, the wildest flights of fancy, in which all high cultures are derived directly and apparently recently from a single source. I have not cited the extremes on the more fanciful side as they are based largely on non-botanical arguments, if any. They are, however, often associated with other less imaginative views, much to the detriment of the latter. Though the

evidence now available may not prove early cultural contact across the Pacific, it is highly suggestive of such contacts. Our knowledge of cultivated plants and of the earlier cultures is not yet so perfect that we may wrap our minds in the comforting cloak of dogma (nor should it ever be thought so). The evidences should be considered on their own merits; further unbiased studies along these lines cannot fail to be of great value, regardless of the light they may or may not throw on the question of early contacts between the New World and the Old. Whatever the relationship between these two areas, the agriculture of the Americas is, in its broad outlines, distinct both in crops and in techniques from that of the Old World, and particularly so from that of temperate Eurasia.

In conclusion, the geographic origins of most cultivated plants can be stated only in regional terms and can never be very narrowly localized. Of the chronological origins, we can scarcely speak yet even in general terms. The cultivated plants are not easy subjects for comprehensive study, and both botanists and anthropologists have too often neglected them. The outlook, however, is very good. With the use of newer tools (carbon 14 and cytogenetics, for example) and the careful reapplication of the older tools of the many phases of both anthropology and botany, there is every reason to believe that a good culture history can be developed for the most basic and important material culture traits of man, his cultivated plants.

Summary

The problems and importance of studying cultivated plants are considered, and the criteria used for determining the center of origin of a cultivated plant are reviewed. The cultivated plants of pre-conquest Mexico are enu-

merated and discussed, with special attention given to the botanical literature and the question of geographic origins. The high development of agriculture and the great diversity of habitat in Mexico are favorable for the development of a great variety of cultivated plants. Over eighty species are listed, which may be summarized as to origins as follows:

1. Mexican–Central American region . . . 71 species
   - 1a. Origin not further localized (including maize, beans and cacao) 8 species
   - 1b. Northern Mexico and adjacent areas (sunflower and a pumpkin species) 4 species
   - 1c. Central Mexico (amaranth, chia, *Opuntia* and a race of the avocado) 24 species
   - 1d. Southern Mexico and lowland Central America (yam bean, indigo and papaya) 27 species
   - 1e. Guatemalan highlands (lima bean, chayote and a race of the avocado) 8 species
2. Andean area (cotton and tobacco) . . . . 6 species
3. Brazil-Paraguay region (pineapple) . . . 3 species
4. Uncertain (chile peppers and sweet potato) 8 species

It will be noted that most of the Mexican cultivated plants are native to Middle America, but that some species have been received through diffusion from the Andean area and from lowland South America. The data do not conflict with the hypothesis of several independent centers of origin for New World agriculture. The origin of agriculture as such is discussed and a gradual development through what may be termed a "commensal" pattern is upheld. The botanical evidences concerning trans-Pacific cultural contact are briefly noted. It is felt that real progress is being made in the study of cultivated plants and that cooperation between different disciplines promises continued and valuable progress in the future.

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EXPLANATION OF THE ILLUSTRATION

PLATE XX. Reproduction of the illustration of *Nicotiana rustica* ("pycielt" or "picietl") and a portion of the discussion of tobacco, from Francisco Hernández: "Rerum Medicarum Novae Hispaniae thesaurus, seu plantarum, animalium, mineralium mexicanorum historia" (Rome 1651) p. 173.